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JPRS L/10363

3 March 1982

East Europe Report

ECONOMIC AND INDUSTRIAL AFFAIRS

(FOUO 2/82)

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BULGARIA

UDC 631.452:631.55

LAND UTILIZATION AS RESOURCE FOR FURTHER DEVELOPMENT OF BULGARIAN AGRICULTURE

Moscow DOKLADY VASKhNIL in Russian No 10, Oct 81 pp 15-17

[Article by G. Koynov, professor and doctor at Plovdiv Higher Agricultural Institute imeni V. Kolarov, People's Republic of Bulgaria: "Rational Use of Land -- An Important Reserve for Increasing the Production of Agricultural Products," (article presented by corresponding member of VASKhNIL N.P. Panov)]

[Text] Tests which we carried out during the 1976-1979 period, with regard to studying the influence of post-harvest crops on the growth, development and grain yields obtained from the principal crops sown following them, have shown that post-harvest crops furnish good yields. Moreover, an increase takes place in the grain yields from crops sown following them as a result of a reduction in the weediness of the soil and enrichment of the soil with nitrogen, owing to improved microorganism activity, a reduction in the content of inhibiting substances and also to an improvement in the phytosanitary condition of the soil.

In Bulgaria there are approximately 0.5 hectares of cultivated land per capita. This is precisely what has forced many scientists and practical workers into searching for the means for obtaining two or three agricultural crop harvests annually or every one and a half years. With irrigation, the climatic conditions of Bulgaria make it possible to obtain two or three yields by cultivating post-harvest crops following barley and wheat harvests.

In the plains regions the first frosts occur during the period from 15 to 20 October. For all practical purposes, there are 90-100 frost-free days from 20 July, following the harvest, to the first frosts. Prior to the average daily temperature dropping to lower than 10° Centigrade in the autumn, the total amount of positive temperatures ranges from 1800 to 2000° Centigrade. Under these conditions, following a barley harvest and in some regions following wheat, it is possible to grow early ripening hybrids of corn, soybeans and sunflowers, millet and beans for both fodder and silage as well as for grain. This has been proven in actual practice on the basis of many experiments carried out at scientific institutes and on many farms. But no studies were carried out on the influence generated by post-harvest crops on the development and yields obtained from crops cultivated following them [1-5]. In this regard, we conducted a study during the 1976-1979 period, in various climatic zones throughout the country, on the effects

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TABLE 1

Influence of Post Harvest Crops on Crops Sown Following Them

Post-Harvest Crop	Yield of Post-Harvest Crop (quintals per hectare)	Increase in Yield: Wheat, Quintals Per Hectare	Wheat, %	Barley, Quintals Per Hectare	Barley, %	Corn, Quintals Per Hectare	Corn, %
Plovdiv (average for 1978-1979):							
soybeans (Zora variety)	12.2	7.7	18.9	7.4	20.0	10.6	11.0
Burgas (average for 1977-1979):							
soybeans (Merit variety)	12.4	7.8	17.8	6.6	17.7	5.3	8.8
Karnobat (average for 1976-1978):							
corn for grain	44.2	-	-	4.1	7.5	-	-
corn for silage	507.8	-	-	6.7	10.0	-	-
corn plus soybeans	363.7	-	-	2.4	4.0	-	-
peas plus sunflowers	402.8	-	-	9.3	15.0	-	-

of post-harvest crops on the development, yields and quality of wheat, barley and corn cultivated following them. The post-harvest crops were sown immediately following a barley harvest (20-30 June). Three waterings were carried out: one prior to the appearance of the seedlings (watering norm of 200-250 cubic meters per hectare) and two -- following their appearance (15-20 July and 1-10 August (watering norm of 600 cubic meters per hectare). It is apparent from the table that post-harvest crops furnish good yields of fodder and grain and that they do not lower the yields obtained from the principal crops sown following them. To the contrary, these yields are increased mainly owing to a reduction in the weediness of the soil (see Table 2). The number of weeds in crops sown following post-harvest soybeans is 3-7 times less and their bulk is 2-3 times lower than the variant in which soybeans were not cultivated.

The yields of crops sown following soybeans also increased owing to enrichment of the soil with nitrogen, as a result of the activity of nodule bacteria which develop on the soybean plant roots, an increase and improvement in the microflora of the soil and an intensification in its activity. It is apparent from Table 3 that following soybeans and throughout the entire growing season for the wheat and barley, the soil is richer in nitrogen and microorganisms, which serve to improve the nitrogen nourishment regime for the plants. In the process, a decrease takes place in the number of microorganisms consuming nitrogen.

An increase in the cropping power also came about owing to an improvement in the phytosanitary condition of the soil and in the crops cultivated following soybeans.(see Table 4).

The studies revealed that the post-harvest cultivation of soybeans lowers the content in the soil of the inhibiting substances

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TABLE 2

Weediness of Crops Sown Following Post-Harvest Soybeans (average for 1978-1979)

Crop	Date of Count	Number of Weeds (Units per m^2)		(Grams per m^2; (dry bulk)	
		Without Soybeans	Following Soybeans	Without Soybeans	Following Soybeans
Wheat	30 March	121	18	21	13
	20 May	42	7	58	21
Barley	30 March	119	43	26	15
	20 May	30	5	67	21
Corn	20 May	132	15	38	12
	20 June	15	4	45	18

Note. Following the 30 March count, the sowings of wheat and barley were sprayed with the herbicide 2.4-D and following the 20 May count -- the corn sowings

TABLE 3

Nitrogen and Microorganism Content in Soil (average for 1978-1979)

Indicator and Phase for Computation	Wheat Without Soybeans	Wheat Following Soybeans	Barley Without Soybeans	Barley Following Soybeans
Ammonium and nitrate nitrogen (mg/ 100 g of soil):				
Tillering	41.3	48.3	40.6	45.3
Shooting	17.2	29.4	12.6	23.7
Ripening	21.9	24.5	22.1	16.2
Hydrolyzed nitrogen (mg/100 g of soil):				
Prior to sowing	42	58	35	56
Shooting	66	64	65	69
Ripening	33	35	28	38
Ammonium fixing bacteria (thousands per gram of soil):				
Shooting	3706	3491	3768	3312
Heading	1211	1787	1917	3958
Ripening	3338	2753	1544	3074
Bacteria which increase on mineral nitrogen (millions of grams of soil):				
Shooting	29.6	14.6	24.0	20.3
Heading	10.3	5.2	7.2	5.2
Ripening	7.3	8.8	4.5	9.1
Microorganisms which decompose cellulose (thousands of grams of soil):				
Shooting	1.5	1.5	1.1	1.2
Heading	1.5	3.4	1.1	2.2
Ripening	0.8	1.2	1.3	1.5

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TABLE 4

Damage Caused By Bacteriosis and Root Rot (average for 1978-1979)

Disease	Wheat		Barley	
	Without Soybeans	Following Soybeans	Without Soybeans	Following Soybeans
Fusarial wilt of ears (% of damaged ears)	1.0	0.7	-	-
Root rot (% of damaged plants)	15.1	6.3	16.8	6.5
Loose smut (% of damaged ears)	0.65	0.40	2.85	2.20

TABLE 5

Effect of a Soil Extract on the Germinative Capacity of Seed and Growth in Young Roots (average for 1978-1979)

Indicator	Extract Taking Phase					
	Tillering		Shooting		Heading	
	Without Post-Harvest Soybeans	Following Post-Harvest Soybeans	Without Post-Harvest Soybeans	Following Post-Harvest Soybeans	Without Post-Harvest Soybeans	Following Post-Harvest Soybeans
Wheat						
Germinative capacity of seed (%)	91	96	91	97	90	96
Length of roots (mm)	46	58	50	60	57	61
Barley						
Germinative capacity of seed (%)	92	97	92	96	91	97
Length of roots (mm)	49	59	51	58	56	61

released by the barley roots. These substances decrease the germinative capacity of the wheat and barley seed and retard the initial growth of the little roots of young plants. We obtained this data during the germination of wheat and barley seed on filter paper that had been moistened with a water extract taken from soil on which soybeans were grown and taken from conventional soil (see Table 5).

Based upon our studies and also upon data furnished by other authors, a state program was developed for intensifying the use of land during the 1980-1985 period. By 1985, 65.5 percent of the irrigated wheat tracts and 100 percent of the irrigated barley tracts will be occupied by post-harvest crops for silage and grain.

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CZECHOSLOVAKIA

NEW 2.6 MILLION-TON STEEL MILL TO OPERATE BY END OF 1983

Prague TECHNICKY TYDENNIK in Czech 8 Dec 81 p 6

[Article by Eng Valter Bohm and Eng Antonin Pindor: "Construction of Oxygen Converter Steel Mill at Trinec; An Important Step in the Modernization of Czechoslovak Metallurgy"]

[Text] In the interest of technical progress in steel production and especially in the interest of making it more efficient, construction of an oxygen converter steel mill is taking place at the Trinec Ironworks of the Great October Socialist Revolution. It will have a capacity of 2.6 million tons per year of steel, and make it possible to terminate production at the obsolescent open-hearth mill II, and to reduce the production of mill III, as well as modifying mill III to operate on the basis of cold charges.

All of the pig iron from the three blast furnaces at Trinec, about 2.1 million tons per year, is processed in converters. The target for steel production, including the output of mill III and of the electric steel mill, will be 3.5 million tons.

This construction project will make it possible to reduce substantially the number of existing economic production units and to terminate what is an environmentally almost unsustainable operation, to reduce the work force by 1.034 employees, to reduce oil consumption by 162,000 tons annually, to reduce steel-making preweight of 1,158 kilograms per ton by about 114 kilograms per ton (which represents a savings of 115,000 tons of metal per year). In addition, the consumption of firing materials will decline 20,000 tons per year and air quality will improve. It is well known that steel mill II currently operates at a level of consumption of 32 standard cubic meters of oxygen per ton, and burns oil with a 1 percent sulphur content, unfavorably affecting the environment in the vicinity of Trinec with emissions of brown smoke and sulphur dioxide. Labor productivity, extended over the entire steel production process at the Trinec Ironworks, will increase almost 41 percent. There will be improvements in the conditions for the production of quality steels, especially in terms of their purity. The construction of an oxygen converter steel works will lead to an increase in profits of more than half a billion korunas annually for the enterprise.

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Time Schedule

The new oxygen converter steel mill is located in the area of the no longer functioning building of the coking plant, the old blast furnaces, steel mill I and the fire brick factory next to the tracks and station of the Czechoslovak State Railroads. Construction will take place in three stages, the first concerned with the oxygen plant, the second and third stages with the mill itself, including the essential auxiliary operations, the engineering infrastructure, and the remaining equipment. The initial draft of stage II was completed in June 1979, and the initial draft of stage III in June 1980. The second stage of construction, which is now in full swing, began in March 1980. At present, the number of temporary buildings has increased, and almost the entire building site has been cleared. Work is progressing on the engineering infrastructure and on the construction of the water management system, and the first pillars of the steel framework for the mill itself have already begun to be set in place.

According to a government decree, the new steel mill is to become operational in December 1983, and construction is to be completed in December 1984, while the planned production of the mill is to be achieved in 1986. The expected construction time, according to the project target and the original design, was established at 58 months. The largest imports from socialist countries are the converters, transporting cars, guniting equipment, the equipment for the introduction of the oxygen lances, for the electromagnetic coagulation of sediment, and other equipment. The largest imports from the capitalist countries are the gas scrubbing apparatus, the automatic control system (ASR), the reduction and venting stations, and several smaller operational systems and equipment items.

Operation of Oxygen Converters

Two converters with a capacity of 160 to 180 tons each will be involved in steel production. The lance for the converter process will be suspended on a special lowering device of Soviet manufacture. One lance will be in operation, and a second lance at full readiness will be in close proximity.

The 180-ton mass of heat is in accordance with the capacity of the chambers of soaking pits. The positioning of the converter bearings on steel stands and concrete footings is being solved so as to make it possible for new stands for converters with a capacity of 200 to 220 tons to be placed on the same footing. The flow capacity of the oxygen lance, and the reduction and venting stations are also being designed for these larger converters. In an attempt to maintain maximal environmental quality, the converters are enclosed by special jacketing which directs product emissions into a gas-scrubbing plant.

Here are some of the parameters of a converter: specific volume, 145 cubic memters; heat mass, 160 to 180 tons; average heat period, 31 minutes; blasting period, 12-14 minutes; maximum blasting intensity, 850 standard cubic meters of oxygen per minute; oxgyen pressure in the lance, 1.5 megapascals; average height of steel level, 1,420 millimeters.

One converter will function during normal operation, but when necessary, the steel mill may operate two converters, although oxygen may not be blown into both converters simultaneously.

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Production Program and Production Technology

The production program and overall production is established on the basis of the prospective requirements of rolling mills, and in accordance with the traditional ongoing programs of the enterprise, nationwide balances, and the needs of the national economy. In addition to low-grade steels, rimming steels and quenched steel, the ironworks will produce annually about 200,000 tons of vacuum-degassed rails, 300,000 tons of steel for patented wire, 35,000 tons of high-quality carbon steel for reinforcing wire, as well as high-quality carburized steel for electrodes, and high-quality alloy steel for construction purposes, wires, springs, and tool steel.

It is evident from this that the production program includes a mix of steels with carbon content up to 0.8 percent. In addition to a static model, a dynamic model is also being built to control problems of carbon and of temperature. With the assistance of special submersible probes--sublances--introduced into the bath, the bath temperature and its carbon content may be determined during the blasting of oxygen. The entire cycle takes from 90 to 120 seconds, counted from the moment of lowering of the sublance. Data gathered with the aid of this probe will indicate deviations of the actual conditions within the convertere from values calculated with the aid of the static control model, and will assure the appropriate corrections, particularly in the amount of blown-in oxygen. It is assumed that there will be a minimal number of heats with unsufficient blasting, and that a minimal amount of carburizing will occur in the pouring ladle.

The use of the dynamic model will improve operational performance and quality thanks to a reduction in the percentage of underblasted and overblasted heats.

The prime contractor for the automatic control system is the Swedish firm Asea, the subcontractor for software is the Swedish firm Datema in conjunction with experts from the Trinec Ironworks. The subcontractor for the sublance equipment, including the static and dynamic models, is the Dutch firm Estel. Production of the sensory elements for the auxiliary probe will be taken care of in Czechoslovakia.

The other systems and facilities are also interesting. For instance, oxygen for the converting process will be provided by an expanded oxygen plant, where the production at three dividing-head machines amounts to 34,000 standard cubic meters per hour, with 99.5 percent purity.

The installed capacity of the turbocompressor is 3.43 megapascals. The oxygen is stored in 10 100-cubic meter tanks at an absolute pressure in the range of 2.2 to 3.43 megapascals. At the valve stations, the oxygen pressure is reduced in such a way that prior to entering the lance it has reached 1.5 megapascals. Two wet-gas scrubbers are from the French firm Clesid. The fan has a capacity of 400,000 standard cubic meters of gas per hour. The entire system guarantees a residual particulate content of less than 100 milligrams per standard cubic meter upon emission. The gas scrubber is controlled by three DS-8 microprocessors from the Asea firm, which communicate with the main computer, a Model PDP 11/34.

Scrap iron is loaded into 50-cubic meter runners at existing scrap stockpiles, the runners outfitted with pressductor railway weights by the Asea firm. Movement

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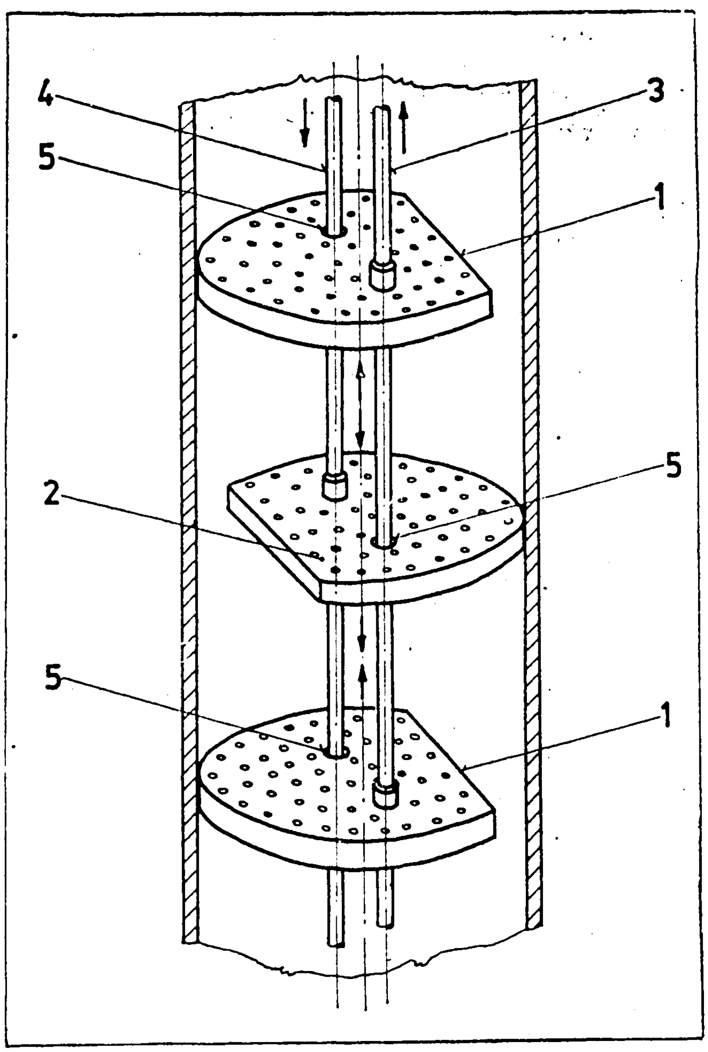
Construction of VPE Extractor



Konstrukce extraktoru VPE se souběžným pohybem pater je vhodná zejména pro aparáty menšího průměru. U velkokapacitních jednotek se osvědčil extraktor s protipohybem pater. Soustava pater je rozdělena na dvě skupiny — 1, 2, které se po výšce střídají. Přitom jsou patra skupiny 1 připevněna k táhlu — 3 a patra skupiny 2 k táhlu — 4, která jsou spojena s dvojitým excentrem udílejícím oběma skupinám pater harmonický pohyb posunutý ve fázi o 180°. Tím se vyrovnávají síly a tlaky působící v zařízení a zvyšuje se stabilita velkých kolon. Protipohyb pater příznivě ovlivňuje vyšší extrakční účinnost.

The design of a VPE extractor with parallel plate movement is appropriate especially for smaller diameter apparatus. For high capacity units, an extractor in which plates move in opposing directions has proven most efficient. The plate system is divided into 2 groups (1;2) which alternate within the column. At the

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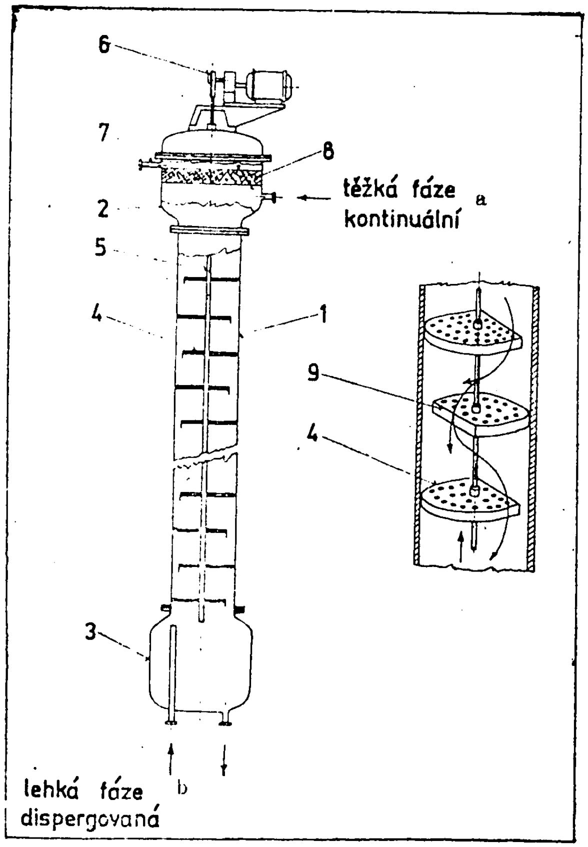
same time, the plates of group 1 are fastened to a rod (3), and the plates of group 2 to a rod (4) which are connected to a dual eccentric which imparts to both plate groups harmonic motion, 180 degrees out of phase. In this way the forces and pressures acting within the equipment are balanced, and the stability of large columns is increased. The opposing movement of plates favorably influences higher extractive efficiency.

Diagram of a Column with Parallel Plate Movement



KEY:
a) heavy phase-continuous b) light phase-dispersed

The body of the column is composed of a cylindrical jacket of the column itself (1) and upper and lower sedimentation tanks (2 and 3). Inside the jacket is located a set of perforated plates (4) fixed to a rod (5) which is joined to the eccentric of a vibration drive (6). This imparts harmonic vibtating movement in the vertical direction to the set of plates. The amplitude and frequency of the vibrations are adjustable. Normally the amplitude fluctuates within a range of a few millimeters and the frequency within the range of 1-6 hertz. Lighter and heavier liquid phases move inside the column in a countercurrent manner under the

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influence of gravity. The lighter phase is introduced into the lower sedimentation tank (3) and exits through the overflow opening (7) in the upper sedimentation tank. In this way the upper surface of the liquid contents of the column is maintained. The heavier phase is introduced into the upper sedimentation tank (2), moves through the column in a countercurrent direction from the lighter phase, and flows out of the lower sedimentation tank (3). On the heavier phase outlet there is fitted an automatic regulating valve which is controlled by the regulator of the phasal interface. The phasal interface is found either in the upper or in the lower sedimentation tank, according to whether the lighter or the heavier phase is to be dispersed into droplets. The figure shows an instance when the lighter phase is to be dispersed, and the interface (8) therefore is located in the upper sedimentation tank (2). The lighter phase droplets formed by the distributor in the lower sedimentation tank, and formed further during their passage through the openings of the vibrating plates, agglomerate at the phasal interface to form a unified film, which then exists through the overflow opening (7). The construction is noted in the right of this diagram. In addition to the small openings for the dispersion of the lighter phase, there are also passages here for the unified, heavier phase (9). The direction of flow of the heavier phase is marked by the arrows. This plate construction permits the achievement of controlled dispersion into droplets of the requisite dimensions and the complete contact of both phases, which are the fundamental preconditions for a high level of efficiency and output.

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of pig iron from the three blast furnaces to the ironworks is carried out by mobile mixers with a cylindrical cross section and removeable face segments, which makes it possible to remove old refractory lining by machine, to improve working conditions for bricklayers, and shorten the time required to renovate the refractory lining. The capacity of the newly relined mixers is 320 tons, which corresponds to the weight of the great majority of blast furnace tappings. There will be 10 mixers, the construction and production of which will be handled at Vitkovice. The repouring of the pig iron into 180-ton pouring ladles will be conducted in a special area. All repouring locations have dust separator apparatus of Trinec design.

Equipment for the vacuum degassing of steel by the DH method is situated on the right side of the converter hall. Vitkovice is the contractor. The equipment is designed to handle a maximum heat weight of 200 tons, and has a capacity of 500,000 tons per year. Mainly rail and steel and certain specialized steels will be processed on the DH equipment.

Another component of the system is equipment for the washing of melts, casting houses, stripping halls, and a preparation plant for molded bottom plates with inert gases, and the injection of insulation inserts into molds, etc.

Fifty percent of the production will be poured into molds from below. In the two casting houses there are four casting platforms. The casting set is approached from two sides, and in each casting house there are two pouring cranes with a capacity of 300 tons each for loading and pouring from foundry ladles. Handling of ingots is taken care of by semiportal gantry cranes which travel above the casting surface, while bracket cranes are available for other auxiliary tasks. All the foundry ladles are outfitted with sliding closures.

Automatic Control System

This extensive and complicated process will be controlled by an integrated control system. The ASR is divided into three levels, which are mutually interrelated, but which may also function separately.

The lowest level of control (the so-called basic control system - BCS) controls the basic technological aggregations and loops, as well as certain technical operations. In addition to communicating with operators and with other systems (LDS and PCS), it manages the weighing of scrap, pig iron, the container weights of converter and ladle additives, crane weights, the control system for the positions of the oxygen lances and sublances. It weighs with weights outfitted with magneto-elastic scanners (manufactured by Pressductor) and with DS-8 micro-computer systems supplied by the Swedish Asea firm.

A superior, computerized level of control is linked with this basic level of control--an automatic control system for technical processes (ASR TP), and an ASR for production processes (ASR VP). These two levels of control are implemented by means of a model PDP 11/34 computer of American manufacture.

The basic task of the ASR TP (the LD system) is the control of the course of a melt, according to the static and dynamic models. It also takes care of

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additional activities such as the planning of heats, the monitoring of scrap preparation by registering the circulation and condition of runners, including the potential for specifying for the operator the requirements for corrections, the assurance of pig iron preparation for a given heat, the calculations in the event of underblasting, the control of alloying. It also monitors the condition of the equipment of the oxygen converter steel mill, and reports concerning the progress of heats and the processing of information from various sensors, with the objective of monitoring the process and its necessary changes. The LD system gathers and provides statistical data for production statistics, transmits them to the PC system, and handles troubleshooting in the event of system disruption.

The task of the ASR VP (the PC system) is the short-term planning of production (for 24-48 hours), the control and monitoring of production (argonizing, vacuum degassing, casting halls, the pouring of ingots and the preparation of ladles). It includes the ability to depict the results of the chemical analysis of steel samples, and services for the clearing center. One of its important functions is to communicate with the enterprise's IBM 370/148 system. This communication may take place with a maximum speed of 2,400 Bauds, with the PC system transmitting data concerning planned and actual production, and data concerning heat procedures. The IBM system will transmit data concerning the production plan, and reports concerning the movement of freight cars carrying raw materials.

A Continuous Casting Factory

At a later date, this oxygen converter steel mill will likewise be outfitted as a factory for the continuous casting of steel. Even though this project is not directly integrated into the current stages of construction, we expect that it will be initiated immediately after the startup of converter operation, because of its extraordinarily high economic contribution stemming mainly from savings of metal and energy. A total of 730,000 tons of grade 10, 11, and 12 steel should be cast continually per year, which is about 27 percent of the steel produced at the oxygen converter steel mill. Billets will be heated in a walking-beam furnace which will already have been implemented by this time and, by means of a number of welds reduced by one-third in comparison with the number of ingots, roughed down for the profile sequence of the reversing mill without cutting the ends with block shears, which clearly will substantially reduce production waste.

The continuous-casting factory will be of the radial type using a curved mold. The radius of the curve will be 14 meters, there will be 6 casting flows, the average length of a billet will be 6,000 millimeters, and the maximum length 12,000 millimenters. The pre-weight of a continuous casting depends on the number of sequential heats and will amount, on the average, to 1,027.8 kilograms per ton. The pouring ladle will be mounted on a pivoting pouring stand. It is expected that the payback period of the investment will be about 4 years.

The construction of the oxygen converter steel mill is the largest capital investment in Trinec since the liberation and will contribute substantially to the modernization of Czechoslovak metallurgy.

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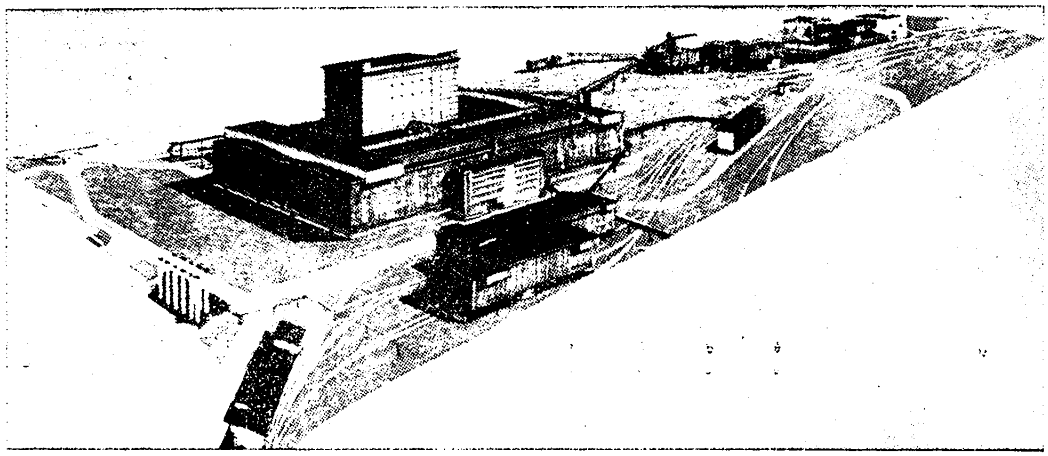
Drawing 1. Trinec Ironworks of the Great October Socialist Revolution--Overall View



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CZECHOSLOVAKIA

NEW CHEMICAL SEPARATOR TO INCREASE EFFICIENCY

Prague TECHNICKY TYDENNIK in Czech 8 Dec 81 p 11

[Article by Dr Eng Jaroslav Prochazka, Candidate for Doctor of Science; portions between slantlines in boldface]

[Text] As an apparatus serving to extract substances during chemical processes, the extractor is nothing new, nor are any of the various types of extraction columns anything unknown for us. What caught our attention was the development and design of a new type which significantly increases the efficiency of all extractive processes.

The beginning of the development of a new type of this piece of apparatus, which is so often used in various branches of industry, falls in the middle of the sixties. At that time the employees of the Extraction Research Group at the Institute of Theoretical Foundations of Chemical Technology of the Czechoslovak Academy of Sciences, located at Prague-Suchdol, reached the conclusion that it would be possible to increase the efficiency and performance of extractors substantially by utilizing the vibrational movement of their components. The goal was the development of a new type of apparatus and systematic research on several processes which, it was assumed, could influence the characteristics of this equipment in a decisive manner.

/Liquid extraction is one of the so-called separational processes by which industry obtains valuable compounds from liquid mixtures and which induce chemical reactions among partially miscible liquids. The process is common in the chemical industry, in hydrometallurgy, in the liquid-fuel-processing industry, in pharmacy, in the food industry, in the purification of waste water, and the like./ The advantage of extraction in comparison with distillation, which may likewise be used frequently for the separation of liquid mixtures, is primarily the possibility of reducing or completely eliminating steam consumption, and often, as well, its greater selectivity or the ability to separate compounds which are very difficult to separate by means of distillation.

What Is It For, Anyway?

Liquid extraction is based on bringing an unrefined liquid mixture into contact with an appropriate solvent which is not very soluble in the original mixture, but which dissolves well certain of its constituent compounds. The maximum amount

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of such compounds that a given solvent may dissolve in itself determines its capacity, while the percentage of solubility of the desired compounds and the solubility of impurities determine its selectivity.

/To be sure, the properties of a solvent influence extraction and the costs for raw materials and energy, but whether actual production approaches the expected or achieves substantially poorer results depends on the characteristics of the extraction equipment and the way it is operated./ This is true because capacity and selectivity characterize equally important properties of a liquid system, i.e., the composition which the system will reach after an infinite period of contact between both liquid phases. However, in a actual piece of apparatus from which is expected a certain volume output in terms of the raw materials which are processed, the contact period is finite.

/It is true that the longer the contact period is to be, the larger must be the apparatus for a given phase flow, and the higher are the investment and, often, the operational costs for the extraction process./

It Fulfilled Preconditions

The output and efficiency of an extractor are not determined solely by its size, but also by its type and mode of operation. It is clear that the larger the contact surface between both liquids in the apparatus the more rapidly will the interspersion of compounds between the raw material and the solvent take place. Therefore, it is necessary to disperse thoroughly one liquid in the other, with the aid, for instance, of rotating mixers. However, tiny droplets representing a large contact surface within the apparatus slowly settle to the bottom, limiting the volumetric output of the extractor. /Therefore, the design of an extractor and its mode of operation should provide for optimal circulation and dispersion of the phases, at the same time that great speed should be achieved in the interspersion of matter between the phases in conjunction with a high volume of phase flowthrough. Apparatus which would significantly outperform existing extractors in these areas would contribute significant savings to production and simultaneously permit the use of extraction even in those technologies where it has not yet been considered due to high costs for equipment./

Approximately such considerations occurred at the inception of thinking about the development of an extractor with vibrating plates, VPE (Vibrating Plate Extractor). The vibrational movement of perforated, horizontal plates is to be used for the dispersion of one of the phases into droplets, thereby achieving even dispersion along with optimal droplet size and a minimal outlay of energy for dispersion. The apparatus should have the shape of a vertical column with countercurrent flow of the phases induced by the difference in their densities. Plate construction should make possible the free passage of the united phases, so that the movement of droplets in the dispersed phase is restricted as little as possible. By this means high volume outputs should be achieved!

Impractical Path Coshen

There was still a long way to go from the basic idea of the construction of an industrial extractor. An appropriate shape for the apparatus and its internal

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components had to be found, and the influence studied of all constructional and operational parameters, as well as the physical properties of liquid systems. At the same time, the production of the extractor ought not be technically difficult and the proposed apparatus had to be operationally reliable and easy to maintain. It was often a matter of conflicting requirements, and for this reason the thought of utilizing vibrational movement in columnar extractors was considered at this time throughout the world as technologically impractical.

Techniques of physical and mathematical modeling were applied to this development. Physical modeling makes use of physical similarities of actions taking place under certain conditions in models of apparatus of varying sizes. An operational unit may then be designed on the basis of measurement results on the small model. Mathematical modeling is directed toward the formulation of systems of mathematical relationships, which make possible the prediction of the behavior of equipment of given dimensions by solving this system.

Five years passed from the idea to the conception of the first industrial VPE extractor. It was first employed in the production of caprolactam (an intermediate product in the production of silon) following preliminary semioperational tests at the W. Pieck Chemical Plants of the Vah River Area in Zilina. /Only the successful outcome of these semioperational tests on a glass column 300 millimeters in diameter and 5 meters high, produced in the workshops of the institute, convinced the technical public of the advantages of this new type of extractor. In the course of a year, two more units were built in Zilina, and two at Spolana in Neratovice./

Universal Properties

In comparison with the normally utilized types of extractional columns in which, for instance, rotating mixers are used for phase dispersion, /a vibrational extractor of the same size typically has a volumetric output that is several times greater, and significantly better extractive efficiency. It is appropriate, therefore, for high-tonnage production, and for production which requires a high level of product purity./ This universality is increased by the fact that both aqueous and organic phases may be dispersed in the extractor, meaning that nonagglomerating emulsions do not occur in the case of mixtures which are difficult to process.

/High output, efficiency, reductions in investment costs and occupied space, savings of energy and raw materials are thus the result of the work of the research and development employees of the CSAV./ The relatively simple construction of the extractor simplifies assembly, maintenance and the processing of substances with corrosive properties. With an increase in the size of the extractor, the efficiency and maximum standard output (output per unit diameter of the apparatus) changes only a little.

And Production Implementation?

Following the refining of caprolactam, the VPE extractor was used in the production of the medicine efedrine at the Roztoky Research Institute of Antibiotics and Biotransformations, and for the refining of mononitrotoluene at the Semtin East Bohemian Chemical Factories Synthesia. These positive results stimulated the

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interest of our chemical engineering industry. The Kralovopolska Machine Works in Brno undertook the machine development of high-capacity VPE extractors and included the columns in its production program. To date the largest column which it has produced is an extractor for obtaining phenols from waste water for the A. Zapotocky Fuel Combine in Uzina. The column has a diameter of 1,200 millimeters and a height of 15 meters, with a capacity of 90 tons of waste water per hour.

/The construction of the VPE vibrational plate extractor is covered by the Czechoslovak AO and by foreign patents. Its designers have also received inventor's certification for technological procedures which utilize extractors and which were developed in conjunction with research institutes and Czechoslovak industrial firms. The extractor has won two gold medals. Last year the collective of employees which shared in the development and application of the extractor received the Prize of the Federal Ministry for Technology and Investment Development.

Interest in the apparatus has also been expressed abroad, for instance for the refining of aromatic nitrohydrocarbons, for rubber production, etc.

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